REMARKS/ARGUMENTS

The specification has been conformed to correspond to the preferred format for U.S. patent applications as required in the Office Action, and a Substitute Specification and Comparison Copy are submitted herewith.

Claims 1-22 are pending in this application.

The drawings were amended as required in the Office Action by adding descriptive legends to the boxes in Figs. 1 and 2.

Applicant notes with appreciation the indicated allowability of dependent claims 4, 5, 8, 9, 12, 14-17, 19 and 20.

Claims 1, 7, 10, 11 and 18 were rejected for anticipation by Nagasaka (6,157,744).

Claims 1 and 6 were additionally rejected for anticipation by Kawabata (4,783,833).

Claims 2, 3 and 21 were rejected for obviousness over Nagasaka in view of Kawachi (6,285,787).

Finally, claims 13 and 22 were rejected for obviousness over Kawabata and Katayama (6,640,004).

The present invention is for detecting objects in a monitored region, such as a safety zone at a dangerous machine, which reliably detects intrusions into the monitored zone, for example by a person or hand of the person, while preventing the triggering of undesired, erroneous signals resulting, for example, from vibrations or other events which do not constitute intrusions of objects into the monitored zone.

For this purpose, the present invention records an actual image of the monitored region with a camera. The actual image of the monitored region is used to derive at least one actual measured value with information on differences between at least two different image

regions of the monitored region and which is invariant with respect to image displacements, image rotations and/or image size changes. This actual measured value is compared with a corresponding reference value derived from a stored reference image that was previously recorded by the camera. If the actual measured value has a pre-set deviation from the reference value, that is, if the measured value exceeds a pre-established threshold reference value, an object recognition reaction is triggered.

Nagasaka relates to the detection of a point of change between video shots or conspicuous frames of one or more succeeding frames. In a video already recorded, a histogram for each frame is generated which is compared with a histogram of an immediately proceeding frame, as well as further preceding frames. This is done to determine whether there exists a short-time change or continuous change of a histogram lasting for one or a few frames. If a short-time disturbance exists, then it can be concluded that this frame probably contains important information, e.g. due to captured flashlight caused by photographers taking a photo of an important event (col. 5, lines 42-47 of Nagasaka). In case a continuous change of a histogram exists, then it can be concluded that a scene has changed permanently.

Nagasaka discloses a video editing system for the off-line editing of video scenes without any real-time monitoring. Nagasaka only compares the histograms of succeeding frames (pictures), wherein each histogram is created directly from the respective frame (picture). In contrast, the present invention generates an actual measured value which provides information on differences between two different image regions of one picture. Moreover, the measured value is invariant with respect to image displacements, image rotations and/or image size changes.

The video editing system of Nagasaka is used to detect scenes with flashlight illumination and not to detect objects. Such flashlight illuminations are exactly what is not to be detected by the method and apparatus of the present invention. Specifically, a flashlight illumination should not lead to an object recognition reaction because pursuant to the present invention a flashlight illumination is a disturbing reflection but not an intruding object. An invariant measured value as required by the present application can only be obtained if

histograms of two different regions of one and the same frame are generated and compared by differentiating. In such an event, the difference can then be compared with a corresponding reference value, in which event the differences of the histograms with and without flashlight illuminations would be the same, which means they would be invariant. Nagasaka provides no teaching and gives no hint for such an approach. However, this is what is disclosed and claimed in the present application.

Claim 1 is limited amongst others to a method in which "at least one actual measured value is derived from the actually recorded image which provides information on differences between at least two different image regions and which is invariant with respect to image displacements ...; this actual measured value is compared with a corresponding reference value derived from a stored reference image", and a reaction is triggered when the difference exceeds a pre-set threshold or deviation of the measured value.

Similarly, apparatus claim 18 requires amongst others "a device for the derivation of at least one actual measured value from the actually recorded image, with the measured value supplying information on differences between at least two different image regions and being invariant with respect to image displacements ... and an object recognition stage for the triggering of an object recognition reaction on the finding of a pre-set deviation of the actual measured value from [a] reference value".

Nagasaka never generates an actual measured value of differences between at least two different image regions, which is invariant with respect to image displacements. Nagasaka describes its image processing as follows:

> ... a processing device for calculating a feature quantity of video image data for each frame, determining a first correlation coefficient between a feature quantity of a current frame and a feature quantity calculated from an immediately preceding frame, determining a second correlation coefficient between the feature quantity of the current frame and a feature quantity of at least two frames preceding the current frame, and indicating on the display a point of change between video shots when the first correlation coefficient and the second correlation coefficient are out of predetermined allowable ranges (col. 2, lines 47-57)

Since Nagasaka neither discloses nor in any form suggests the above-discussed recitation of claims 1 and 18, it does not anticipate them, and the claims are patentable over Nagasaka.

In this context, applicants noted the observation in the Office Action that Nagasaka "provides information on differences between at least two different image regions and which is invariant with respect to image displacements ...." The claims of the present invention require to generate an "actual measured value" from the "actually recorded image" and which provides information concerning "at least two different image regions and which is invariant with respect to image displacements". Nagasaka has no corresponding disclosure.

Claims 1 and 6 were further rejected for anticipation by Kawabata, again because the reference was viewed as disclosing an "actual measured value derived from the actually recorded image which provides information on differences between at least two different image regions and which is invariant with respect to image displacements".

Kawabata concerns a method for extracting an image of a moving object from a background which is subject to changes, since the camera which is used to capture the image is moved across the scene. Edge enhancements are performed on the object and on the background as well. The background which moves in relation to the camera during capturing the image is tracked by calculation so that when two images are subtracted, objects of the background are canceled and only the moving object in the foreground remains.

Kawabata uses normal filtering operations to enhance the edges of the objects and uses differentiating of images to extract the moving object. The displacement of the background is calculated by a correlation function which is based on the principle that the background displaces between succeeding frames one pixel in eight directions on the picture plane at a maximum. The background image is moved in the direction in which a maximum correlation value occurs. This operation is done on each entry of an image.

Kawabata does not generate an invariant measured value by using the differences between the two different image regions.

Thus, Kawabata does not anticipate claims 1 and 6, which are therefore allowable.

In this context, applicants disagree with the observation in the Office Action that Kawabata generates actually measured values from the recorded image which are "invariant with respect to image displacements ...." The relied-on portion of Kawabata, column 3, lines 4-6 of the reference, provides no such disclosure and only states that an edge enhanced image of the input image stored in the picture memory is extracted. There is no suggestion, much less any teaching, that the image is or should be invariant with respect to image displacement.

Claims 2, 3 and 21 were rejected for obviousness over Nagasaka in view of Kawachi.

These claims, which depend from independent claims 1 or 18, necessarily include the limitations of their parent claims, which, for reasons discussed above, are not disclosed or suggested by Nagasaka. Kawachi does not provide what is missing from Nagasaka. Thus, for this reason alone, claims 2, 3 and 21 are allowable over the applied references.

In addition, these claims are patentable over Nagasaka and Kawachi in their own right because Kawachi does not disclose or in any way suggest to use the projected structure at the monitoring region to define a measuring value with which a change in the captured image could be detected. Kawachi discloses to use the measuring value only for defining the region for the comparison.

Thus, claims 2, 3 and 21 are allowable over Nagasaka and Kawachi in their own right.

Claims 13 and 22 were rejected for obviousness over Kawabata in view of Katayama.

Like claims 2, 3 and 21, claims 13 and 22 depend from parent claims which are allowable over Kawabata for the reasons discussed above. Katayama was relied on solely for showing the use of a light source. However, Katayama does not supply what is missing from Kawabata. Accordingly, claims 13 and 22 are not obvious over Kawabata and Katayama.

CONCLUSION

In view of the foregoing, applicants submit that all claims are patentable and requests a formal Notice of Allowance at an early date.

If the Examiner believes a telephone conference would expedite prosecution of this application, please telephone the undersigned at (415) 576-0200.

Respectfully submitted,

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Amendments to the Drawings:

Attached hereto are two sheets of drawings for Figs. 1 and 2, which were revised to label the boxes in the drawings. Please substitute the attached drawings for those originally filed with this application.

Attachment: Replacement Sheets